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PHYSICS

SEMICONDUCTORS

Single Correct Answer Type

1. Forbidden energy gap in a semiconductor is
   a) 1 eV b) 6 eV
   c) 0 eV d) 9 eV
2. In a p-n junction diode,
   a) the current in the reverse biased condition is generally zero
   b) the current in the reverse biased condition is small but the forward biased current is independent of the bias voltage
   c) the forward biased current is strongly dependent on the applied bias voltage
   d) the forward biased current is very small in comparison to reverse biased current
3. The forbidden energy gap in Ge is 0.72 eV. Given, hc = 12400 eV - A. The maximum wavelength of radiation that will generate electron-hole pair is
   a) 172220 A b) 172.2 A
   c) 17222 A d) 1722 A
4. In insulators CB is conduction band and VB is valence band
   a) VB is partially filled with electrons
   b) CB is partially filled with electrons
   c) CB is empty and VB is filled with electrons
   d) CB is filled with electrons and VB is empty
5. In case of $p-n$ junction diode, the width of depletion region is
   a) decreased with heavy doping
   b) increased by reverse biasing
   c) decreased with light doping
   d) increased by forward biasing
6. With forward biased mode, the p-n junction diode
   a) is one in which width of depletion layer increases
   b) is one in which potential barrier increases
   c) acts as closed switch
   d) acts as open switch
7. At absolute zero temperature, pure silicon behaves as
   a) non-metal b) insulator
   c) metal d) extrinsic semiconductor
8. In reverse bias p-n-junction diode depletion layer width
   a) Decreases b) Increases
   c) Remain same d) Can't predicted
9. What enables Ge behave as semiconductor even though all electrons in the valence band form covalent bonds? It is due to the small width of
   a) valence band b) conduction band
   c) forbidden energy gap d) None of these
10. Reverse bias applied to a p-n junction diode
    a) lower the potential barrier
    b) decreases the majority charge carriers
    c) raises the potential barrier
    d) changes the mass of p-n junction diode
11. The majority charge carriers in p-type and n-type semiconductor are respectively
    a) Electrons and electrons b) Holes and electrons
    c) Holes and holes d) Electrons and holes
12. Serious drawback of the semiconductor device is that they
    a) cannot be used with high voltage
    b) pollute the environment
    c) are costly
    d) do not last for long time
13. At elevated temperature, few of covalent bonds of Si or Ge are broken and a vacancy in the bond ia created. Effective charge of vacancy or hole is
    a) positive b) negative
    c) neutral d) sometimes positive and sometimes negative
14. The diffusion current in a $p-n$ junction is
    a) from the n-side to the p-side
    b) from the p-side to the n-side

c) from the n-side to the p-side, if the junction is forward biased and in the opposite direction, if it is reverse biased
d) from the p-side to the n-side, if the junction is forward biased and in the opposite direction, if it is reverse biased

15. In an intrinsic semiconductor, at an ordinary temperature, the correct relation between the number of electrons per unit volume n_θ and number of holes per unit volume n_h, is
a) $n_\theta = n_h$
b) $n_e > n_h$
c) $n_\theta < n_h$
d) $n_\theta = n_h = 0$

16. In a p-type semiconductor, germanium is dopped with
a) gallium
b) boron
c) aluminium
d) All of these

17. In the forward bias arrangement of a p - n-junction diode, the
a) n-end is connected to the positive terminal of the battery
b) p-end is connected to the positive terminal of the battery
c) direction of current is from n-end to p-end in the diode
d) p-end is connected to the negative terminal of battery

18. In the arrangement shown below, the current through diode is

a) 1 mA
b) 10 mA
c) Zero
d) 20 mA

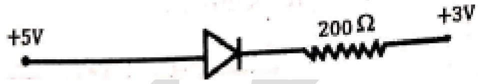
19. There is no hole current in good conductors, because they
a) have large forbidden energy gap
b) have overlapping valence and conduction bands
c) are full of electron gas
d) have no valence band

20. If p-n junction diode is reverse biased then
a) Width of the depletion layer decreases
b) Potential barrier decreases
c) Width of the depletion layer increases
d) Electrical conduction is possible

21. If p-n junction diode is forward biased then
a) Barrier potential increases
b) Width of depletion layer increases
c) Electric conduction is not possible
d) Width of depletion layer decreases

22. The conductivity of a semiconductor increases with increase in temperature, because
a) number density of free current carries increases
b) relaxation time increases
c) both number density of carries and relaxation time increase
d) number density of carries increases, relaxation time decreases but effect of decrease in relaxation time is much less than increase in number density

23. The current in the following circuit is



a) 10 A
b) Zero
c) 0.025 A
d) 10^{-2} A

24. Breakdown in a semiconductor diode occurs when
a) The potential barrier becomes zero
b) Reverse bias exceeds a certain value
c) Forward bias exceeds a certain value
d) Forward current exceeds a certain value

25. The dominant mechanisms for motion of charge carriers in forward and reverse biased silicon $p - n$ junctions are
a) drift in forward bias, diffusion in reverse bias
b) diffusion in forward bias, drift in reverse bias
c) diffusion in both forward and reverse bias
d) drift in both forward and reverse bias

26. The region near the junction of an unbiased p-n junction diode is known as depletion layer. The layer is depleted of
a) Both positive and negative ions
b) Only negative ions
c) Electrons and holes
d) Only positive ions

27. At room temperature, a p-type semiconductor has
a) Equal number of free electrons and holes
b) Large number of free electrons and few holes
c) Large number of holes and few electrons
d) No electrons or holes

28. Semiconductor is damaged by the strong

current due to

a) lack of free electron
b) excess of electron
c) excess of proton
d) None of the above

29. The depletion layer in $p-n$ junction region is caused by
a) drift of electrons
b) migration of jmpurity ions
c) diffusion of charge carriers
d) drift of holes

30. Let n_p and n_e be the numbers of holes and conduction electrons in n-type extrinsic semiconductor
a) $n_p > n_e$
b) $n_p = n_e$
c) $n_p < n_e$
d) $n_p \neq n_e$

31. Let n_p and n_e be the number of holes and conduction electrons respectively in a semiconductor. Then,
a) $n_p >$ ne in an intrinsic semiconductor, $l < l_p + l_e$
b) $n_p =$ ne in an extrinsic semiconductor, $l > l_p + l_e$
c) $n_p =$ ne in an intrinsic semiconductor, $l = l_p + l_e$
d) $n_p >$ ne in an intrinsic semiconductor, $l = 0$ (Here, l_p = current due to holes movement, l_e = current due to electrons movement, l = total current)

32. GaAs is
a) an elemental semiconductor
b) alloy semiconductor
c) bad conductor
d) metallic semiconductor

33. The valence band and conduction band of a solid, overlap at low temperature, the solid may be
a) a metal
b) a semiconductor
c) an insulator
d) None of these

34. In reverse bias p - n-junction, diode depletion layer width
a) decreases
b) increases
c) remain same
d) Can't predicted

35. If a p-n junction diode is not connected to any circuit, then
a) the potential is the same everywhere
b) the p-type side has a higher potential than the n-type side
c) there is an electric field at the junction directed from the n-side to p-side
d) there is an electric field at the junction directed from the p-type side to n-type side

36. Resistance of thermistor changes with change of surrounding
a) pressure
b) temperature
c) Both (a) and (b)
d) Neither (a) nor (b)

37. Hole is
a) an anti-particle of electron
b) a vacancy created when an electron leaves a covalent bond
c) absence of free electrons
d) an artificially created particle

38. Choose the FALSE statement from the following
a) Generally, in conductors the valence and conducting bands overlap
b) The resistivity of a semiconductor increases with increase in temperature
c) The conductivity of a semiconductor increase with increase in temperature
d) Substances with energy gap of the order of 10 eV are insulators

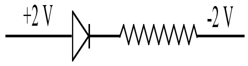
39. In a n-type semiconductor, which of the following statements is true?
a) Electrons are majority carriers and trivalent atoms are dopants
b) Electrons are minority carriers and pentavalent atoms are dopants
c) Holes are minority carriers and pentavalent atoms are dopants
d) Holes are majority carriers and trivalent atoms are dopants

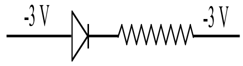
40. The depletion layer in a p-n junction diode is 10^{-6} m wide and its knee potential is 0.5 V, then the inner electric field in the depletion region is
a) $5 \times 10^{6} \mathrm{Vm}^{-1}$
b) $5 \times 10^{-7} \mathrm{Vm}^{-1}$
c) $5 \times 10^{5} \mathrm{Vm}^{-1}$
d) $5 \times 10^{-1} \mathrm{Vm}^{-1}$

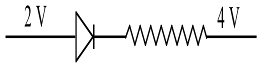
41. The drift current in a $p-n$ junction is
a) from the n-side to the p-side
b) from the p-side to the n-side
c) from the n-side to the p-side, if the junction is forward biased and in the opposite direction, if
d) from the p-side to the n-side, if the junction is forward biased and in the opposite direction, if

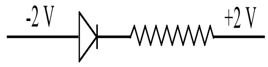
it is reverse biased — it is reverse biased

42. In good conductors the gap between the valence band and the conduction band is
   a) Large but not infinite
   b) Infinite
   c) Zero
   d) Small but not zero

43. The forward biased diode connection is
   a) 

   b) 

   c) 

   d) 

44. Band gap of silicon is E_g (Si), of germanium is E_g (Ge) and of carbon is E_g (C) . The correct order of band gap is
   a) E_g (Si) < E_g (Ge) < E_g (C)
   b) E_g (Si) > E_g (Ge) < E_g (C)
   c) E_g (Si) < E_g (Ge) < E_g (C)
   d) E_g (Si) > E_g (Ge) > E_g (C)

45. Pure silicon at 300 K has equal electron (n_e) and hole (n_h) concentration of 1.5×10^{16} m^{-3}. Doping by indium increases n_h to 4.5×10^{22} m^{-3}. The n_e in the doped silicon is
   a) 9×10^5
   b) 5×10^9
   c) 2.25×10^{11}
   d) 3×10^{19}

46. The valency of the impurity atom that is to be added to germanium crystal, so as to make it a n-type semiconductor, is
   a) 6
   b) 5
   c) 4
   d) 3

47. Electrical conductivity of intrinsic and p-type semiconductor increases with increase in
   a) density
   b) volume
   c) Both (a) and (b)
   d) temperature

48. The width of depletion layer of a p-n junction diode, when it is (i) forward biased and (ii) reverse biased respectively
   a) Decrease and decreases
   b) Decreases and increases
   c) Increases and increases
   d) Increases and decreases

49. When n- type or p-type impurities are added to copper, then
   a) conductivity increases
   b) conductivity does not increase
   c) conductivity becomes zero
   d) None of the above

50. If a small amount of antimony is added to germanium crystal,
   a) the antimony becomes an acceptor atom
   b) there will be more free electrons than holes in the semiconductor
   c) its resistance is increased
   d) it becomes a p-type semiconductor

51. In semiconductors, at room temperature the
   a) valence band is partially empty and the conduction band is partially filled
   b) valence band is completely filled and the conduction
   c) valence band is completely filled
   d) conduction band is completely empty

52. Potential barrier developed in a junction diode opposes
   a) minority carrier in both regions only
   b) majority carrier only
   c) electrons in n-region
   d) holes in p-region

53. An n-type semiconductor is
   a) negatively charged
   b) positively charged
   c) neutral
   d) negatively or positively charged depending upon the amount of impurity

54. In a pure silicon ($n_i = 10^{16}$ per m^3) crystal at 300 K, 10^{21} atoms of phosphorus are added per cubic metre. The new hole concentration in silicon crystal is
   a) 10^5 per m^3
   b) 10^{21} per m^3
   c) 10^{19} per m^3
   d) 10^{11} per m^3

55. An integrated circuit is combination of thousands of
   a) diodes
   b) transistors
   c) Both (a) and (b)
   d) Neither (a) nor (b)

56. When the conductivity of a semiconductor is only due to breaking of covalent bond, the semiconductor is called
   a) intrinsic
   b) extrinsic
   c) p-type
   d) n-type

57. A p-n junction has depletion region of thickness of the order of
   a) 1 cm
   b) 1 mm
   c) 10^{-6} m
   d) 10^{-12} cm

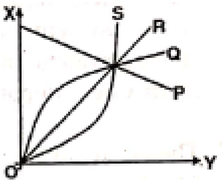
58. In its crystalline structure, every Si or Ge atoms are attached to other atoms by
   a) coordinate bond
   b) electrovalent bond
   c) covalent bond
   d) hydrogen bond

59. In energy band diagram of insulators, a band gap and the conduction band is respectively
   a) Very low, empty
   b) Very low, partially filled
   c) Very high, empty
   d) Very high,

completely filled

60. Choose the correct statement. In conductors
a) Valance band and conduction band overlap each other
b) Valance band and conduction band are separated by large energy gap
c) Valance band and conduction band are separated by a small energy gap
d) A very small number of electrons are available for electrical conduction

61. Which one of the following graph represents forward bias characteristic of a diode?



a) P
b) Q
c) R
d) S

62. In case of p-n junction diode, the width of depletion region is
a) Increased by reverse biasing
b) Increased by forward biasing
c) Decreased with light doping
d) Decreased with heavy doping

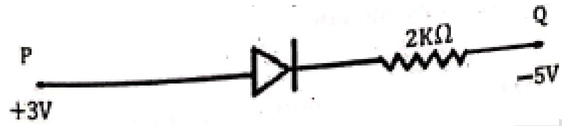
63. In the middle of the depletion layer of reverse biased p-n junction, the
a) electric field is zero
b) potential is infinite
c) electric field is maximum
d) potential is zero

64. In an unbiased $p-n$ junction, holes diffuse from the p-region to n-region because
a) free electrons in the n-region attract them
b) they move across the junction by the potential difference
c) hole concentration in p-region is more as compared to n-region
d) All of the above

65. Diffusion current in a $p-n$ junction is greater than the drift current in magnitude,
a) if the junction is forward biased
b) if the junction is reverse biased
c) if the junction is unbiased
d) None of the above

66. In case of insulators
a) There is no gap between conduction band and valence band
b) Conduction band and valence band overlap each other
c) Conduction band is partially filled and valence band is partially empty
d) Conduction band is empty

67. In an ideal junction diode, the current flowing through PQ is



a) 2×10^{-3} A
b) 2×10^{-2} A
c) 4×10^{-3} A
d) 10^{-3} A

68. An n-type and p-type silicon semiconductor can be obtained by doping pure silicon with
a) Sodium and magnesium respectively
b) Indium and sodium respectively
c) Boron and arsenic respectively
d) Arsenic and boron respectively

69. When a forward bias is applied to $p-n$ junction, then it
a) raises the potential barrier
b) reduces the majority carrier current to zero
c) lowers the potential barrier
d) None of the above

70. A piece of semiconductor is connected in series in an electric circuit. On increasing the temperature, the current in the circuit will
a) decrease
b) remain unchanged
c) increase
d) stop flowing

71. Based on the energy band description, a solid can be classified as an insulator when the energy gap between the valence band and conduction band is
a) $3 \text{ eV} < E_g < 6 \text{ e V}$
b) $E_g > 6$ eV
c) $E_g < 3$ eV
d) $E_g = 0$ eV

72. The depletion layer in the p-n junction diode is caused by
a) Drift of electrons
b) Drift of holes
c) Migration of impurity ions
d) Diffusion of charge carriers

73. When a small amount of impurity atoms are added to a semiconductor then generally its resistivity
a) Increases
b) Decreases
c) Does not change
d) May increase or decrease depending upon the percentage of doping

74. Which one of the following statements is false?
a) Pure Si doped with
b) Majority carriers in a

trivalent impurities gives a p-type semiconductor.

n-type semiconductor are holes.

c) Minority carriers in a p-type semiconductor are electrons.

d) The resistance of intrinsic semiconductor decreases with increase of temperature.

75. Choose the correct statement, In case of insulators,

a) Conduction band and valence band overlap each other
b) Conduction band is empty
c) Conduction band is partially filled and valence band is partially empty.
d) There is no gap between conduction and valence band

76. Silicon and copper are cooled from 300 K to 100 K, the specific resistance (resistivity)

a) Increases in both copper and silicon
b) Decrease in both copper and silicon
c) Decreases in copper and increases in silicon
d) Increases in copper but decreases in silicon

77. The difference in the variation of resistance with temperature in a metal and a semiconductor arises essentially due to the difference in the

a) crystal structure
b) variation of the number of charge carriers with temperature
c) type of bonding
d) variation of scattering mechanism with temperature

78. At room temperature, a p-type semiconductor has

a) large number of holes and few electrons
b) large number of free electrons and few holes
c) equal number of free electrons and holes
d) no electrons or holes

79. The process of adding impurities to the pure semiconductor is called

a) drouping
b) drooping
c) doping
d) None of the above

80. When the temperature of a semiconductor is increased, its resistance and electric conductivity respectively

a) Increases and decreases
b) Decreases and decreases
c) Increases and increases
d) Decreases and increases

81. In the case of insulators, a band gap and conduction band is respectively

a) Very high empty
b) Very low, partially filled
c) Very high, completely filled
d) Very low, empty

82. In a semiconductor diode, the barrier potential offers opposition to only

a) majority carrier in both regions
b) minority carrier in both regions
c) free electrons in the n-region
d) holes in the p-region

83. Electrical conductivity of insulators is

a) Sometimes small and sometimes large
b) Extremely small
c) Exactly zero
d) Extremely large

84. If Np and Ne be the numbers of holes and conduction electrons in an extrinsic semiconductor, then

a) $N_p > N_e$
b) $N_p = N_e$
c) $N_p < N_e$
d) $N_p > N_e$ or $N_p < N_e$ depending on the nature of impurity

85. If p-n junction diode is reversed biased then

a) Width of depletion layer decreases
b) Width of depletion layer increases
c) Electrical conduction is not possible at all
d) Potential barrier decreases

86. The contribution in the total current flowing through a semiconductor due to electrons and holes are $\frac{3}{4}$ and $\frac{1}{4}$, respectively. If the drift velocity of electrons is $\frac{5}{2}$ times that of holes at this temperature, then the ratio of concentration of electrons and hole is

a) 6 : 5
b) 5 : 6
c) 3 : 2
d) 2 : 3

87. A donor impurity results in

a) Production of p-type semiconductor
b) Holes as majority carries and electrons as minority carriers
c) Conduction band just above the filled valence band
d) Production of n-type semiconductor

88. Identify the WRONG statement from the following.
In an intrinsic semiconductor

a) The number of free electrons increases with temperature
b) There are no free electrons at absolute zero temperature
c) The number of free electrons is less than that in a conductor
d) There are no free electrons at any temperature except absolute zero

89. In a p-type semiconductor,
a) Electrons are minority carriers and pentavalent atoms are dopants
b) Holes are majority carriers and trivalent atoms are dopants
c) Electrons are majority carriers and pentavalent atoms are dopants
d) Holes are minority carriers and trivalent atoms are dopants

90. In a n-type semiconductor, which of the following statement is true?
a) Electrons are majority carriers and trivalent atoms are dopants.
b) Electrons are minority carriers and pentavalent atoms are dopants.
c) Holes are minority carriers and pentavalent atoms are dopants.
d) Holes are majority carriers and trivalent atoms are dopants.

91. When p-n junction diode is reverse biased, then the width of the barrier potential will
a) Decrease and it will offer zero resistance
b) Remain constant and it will not offer resistance
c) Increase and it will offer more resistance
d) Decrease and it will offer more resistance

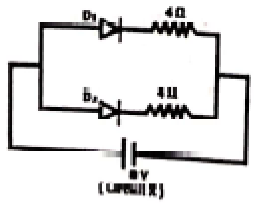
92. Number of electrons in the valence shell of a intrinsic semiconductor is
a) 1
b) 2
c) 3
d) 4

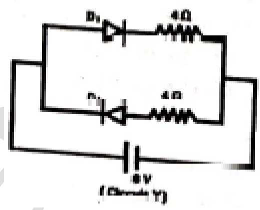
93. When a small amount of impurity atoms are added to a semiconductor, then generally its resistivity
a) may increase or decrease depending upon the percentage of doping
b) increases
c) decreases
d) does not change

94. Which one of the following statements is TRUE for n-type semiconductor?
a) Electrons are minority carriers and pentavalent atoms are dopants
b) Holes are majority carriers and trivalent atoms are dopant
c) Electrons are majority carriers and trivalent atoms are dopant
d) Holes are minority carriers and pentavalent atoms are dopant

95. Electrical conductivity of insulators is
a) Sometimes small and sometimes large
b) Exactly zero
c) Extremely large
d) Extremely small

96. What are the values of the currents flowing in each of the following diode circuits X and Y respectively? (Assume that the diodes are ideal)



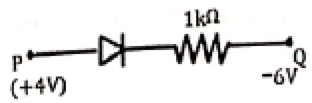


a) 1 A, 2 A
b) 2 A, 1 A
c) 4 A, 2 A
d) 2 A, 4 A

97. The temperature of germanium is decreased from room temperature to 100 K , the resistance of germanium
a) decreases
b) increases
c) remains unaffected
d) depends on external conditions

98. By increasing the temperature of a conductor and semiconductor, if specific resistance
a) Increases and decreases respectively
b) Increases for both
c) Decreases for both
d) Decreases and increases respectively

99. Consider an ideal junction diode. The value of current flowing through PQ is



a) 10^{-3} A
b) 10^{-2} A
c) 0 A
d) 10^{-1} A

100. At absolute zero temperature, intrinsic semiconductor behaves as
a) Conductor
b) Organic semiconductor

c) Insulator
d) superconductor

101. In a semiconductor, the number of holes and number of free electrons are represented as 'n_h' and 'n_e' respectively. Which one of the following statements is TRUE for the semiconductor?

a) In an intrinsic semiconductor, $n_e = n_h$
b) In an extrinsic semiconductor, $n_h = n_e$
c) In an intrinsic semiconductor, $n_h > n_e$
d) In an intrinsic semiconductor, $n_e > n_h$

102. At absolute zero temperature, pure silicon behaves as

a) Superconductor
b) Semiconductor
c) Insulator
d) Conductor

103. Basic building blocks of all electronic circuits are

a) devices in which there is a flow of electrons
b) devices in which there is no flow of electrons
c) devices in which there is a controlled flow of electrons
d) devices in which there is an uncontrolled flow of electrons

104. When forward bias is applied to a p-n junction then what happens to the potential barrier 'V_B' and the width 'W' of the depletion region?

a) V_B increases, W decreases
b) V_B decreases, W increases
c) V_B increases, W increases
d) V_B decreases, W decreases

105. In semiconductor, the concentrations of electrons and hole are 8×10^{18} m^{-3} and 5×10^{18} m^{-3}, respectively. IF the mobilities of electrons and holes are 2.3 m^2 V^{-1} s^{-1} and 0.01 m^2 V^{-1} s^{-1} respectively, then semiconductor is

a) n-type and its resistivity is 0.34 Ω -m
b) p-type and its resistivity is 0.034 Ω -m
c) n-type and its resistivity is 0.034Ω -m
d) p-type and its resistivity is 3.4 Ω -m

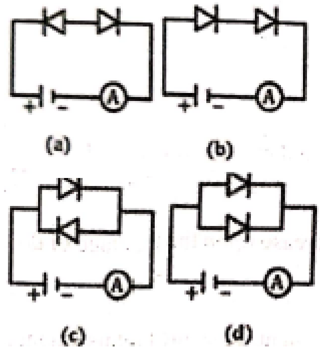
106. The majority charge carriers in p-type semiconductor are

a) electrons
b) protons
c) holes
d) neutrons

107. The major carriers of current in a *p*-type semiconductor will be

a) neutrons
b) protons
c) electrons
d) holes

108. Two identical ideal diodes are connected to an ammeter and a d. c. source (1 volt) as shown. In which one of the following circuits, ammeter will not show any deflection?



a) (d)
b) (a)
c) (b)
d) (c)

109. Correct order of conductivity for metals, semiconductors and insulators, is

a) $\sigma_{semiconductor} > \sigma_{insulator} > \sigma_{metals}$
b) $\sigma_{metal} > \sigma_{semiconductor} > \sigma_{insulator}$
c) $\sigma_{semiconductor} > \sigma_{metals} > \sigma_{insulator}$
d) $\sigma_{insulator} > \sigma_{semiconductor} > \sigma_{metals}$ (Here, s represents conductivity)

110. Choose the correct statement. In semiconductors valance band and conduction band

a) Is separately by large energy gap
b) Is separated by small energy gap
c) Is almost empty
d) Overlap each other

111. In n-type semiconductor,

a) Trivalent impurity are dopants and electrons are minority carriers
b) Pentavalent impurity are dopants and electrons are majority carriers
c) Pentavalent impurity are dopants and holes are majority carriers
d) Trivalent impurity are dopants and holes are majority carriers

112. In a crystal, atomic separation is around 2A to 3A. At this separation due to interatomic interaction, energies of

a) outermost electrons is changed
b) innermost electrons is changed
c) Both (a) and (b)
d) None of the above

113. In a reverse biased p-n junction, when the applied bias voltage is equal to the breakdown voltage, then

a) current remains constant while
b) voltage remains constant while

voltage increases sharply | current increases sharply

c) current and voltage increase
d) current and voltage decrease

114. A piece of copper and the other of germanium are cooled from the room temperature to 80 K, then which of the following would be a correct statement?
a) Resistance of each increases.
b) Resistance of each decreases.
c) Resistance of copper increases while that of germanium decreases.
d) Resistance of copper decreases while that of germanium increases.

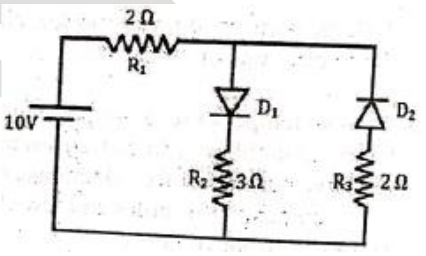
115. The electrical conductivity of p-type semiconductor is determined by the number of
a) Electrons in the valence band
b) Holes
c) Impurity atoms alone
d) Free electrons in the conduction band

116. Choose the correct statement. In conductors
a) Valence band and conduction band overlap each other
b) Valence band and conduction band are separated by a large energy gasp
c) Very small number of electrons are available for electrical conduction
d) Valence band and conduction band are separated by small energy gap

117. Assuming that the junction diode is ideal, the current in the arrangement shown in

a) 20 mA
b) 10 mA
c) 40 mA
d) 30 mA

118. The given circuit has two ideal diodes D_1 and D_2 connected as shown in the figure. The current flowing through the resistance R_1 will be



a) 7 A
b) 2 A
c) 2.5 A
d) 3.3 A

119. In semiconductors at a room temperature
a) The valence band is completely filled
b) The valence band is partially empty and the conduction band is partially filled
c) The valence band is completely filled and the conduction band is partially empty
d) The conduction band is completely empty

120. In an unbiased p-n junction,
a) potential at p is more than that at n
b) potential at p is less than that at n
c) potential at p is equal to that at n
d) potential at p is positive and that at n is negative

121. An n-type and p-type silicon can be obtained by doping pure silicon with
a) arsenic and phosphorous respectively
b) indium and aluminum respectively
c) phosphorous and indium respectively
d) aluminum and boron respectively

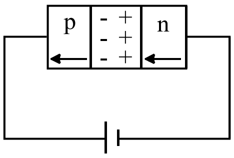
122. In an insulator, the forbidden energy gap between the valence band and conduction band is of the order of
a) 1 MeV
b) 0.1 MeV
c) 1 E V
d) 5 eV

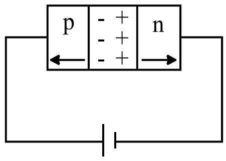
123. The reverse biasing in a $p-n$ junction diode
a) decreases the potential barrier
b) increases the potential barrier
c) increases the number of minority charge carriers
d) increases the number of majority charge carriers

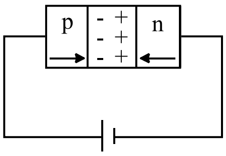
124. Intrinsic semiconductor is electrically neutral. Extrinsic semiconductor having large number of current carriers would be
a) positively charged
b) negatively charged
c) positively charged or negatively charged depending upon the type of impurity that has been added
d) electrically neutral

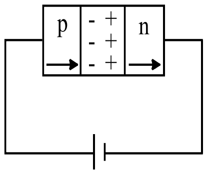
125. In a semiconducting material, the mobilities of electrons and holes are μ_e and μ_h, respectively. Which of the following is true?
a) $\mu_e > \mu_h$
b) $\mu_e < \mu_h$
c) $\mu_e = \mu_h$
d) $\mu_e < 0, \mu_h > 0$

126. In the case of forward biasing of a p-n junction diode, which one of the following figures correctly depicts the direction of conventional current (indicated by an arrow mark)?

a) 

b) 

c) 

d) 

127. In a good conductor, the energy gap between the conduction band and the valence band is

a) infinite
b) wide
c) narrow
d) zero

128. The probability of electrons to be found in the conduction band of an intrinsic semiconductor at a finite temperature

a) decreases exponentially with increasing band gap
b) increases exponentially with increasing band gap
c) decreases with increasing temperature
d) is independent of the temperature and the band gap

129. In $p-n$ junction, avalanche current flows in circuit when biasing is

a) forward
b) reverse
c) zero
d) excess

130. In a pure silicon, number of electrons and holes per unit volume are $1.6 \times 10^{16}\ \mathrm{m}^{-3}$. If silicon is doped with Boron in a way that on doping hole density increases to $4 \times 10^{22}\ \mathrm{m}^{-3}$. Then electron density in doped semiconductor will be

a) $6.4 \times 10^{-9}\ \mathrm{m}^{-3}$
b) $6.4 \times 10^{9}\ \mathrm{m}^{-3}$
c) $6.4 \times 10^{-10}\ \mathrm{m}^{-3}$
d) $6.4 \times 10^{10}\ \mathrm{m}^{-3}$

131. In a forward bias arrangement of a p-n junction diode,

a) The p-region is connected to negative terminal of the battery
b) p-region is connected to the positive terminal of battery
c) n-region is connected to the positive terminal of battery
d) Direction of conventional current is from n-region top-region in the diode

132. Pure silicon crystal at 300 K has equal electron $(\mathrm{n_e})$ and hole $(\mathrm{n_h})$ concentration of $1.5 \times 10^{16}\ \mathrm{m}^{-3}$. Doping by indium increases $\mathrm{n_h}$ to $4.5 \times 10^{22}\ \mathrm{m}^{-3}$. The ne in the doped silicon is

a) 2.25×10^{11}
b) 9×10^{6}
c) 5×10^{9}
d) 3×10^{12}

133. In germanium crystal, the forbidden energy gap in joule is

a) zero
b) 1.6×10^{-19}
c) 1.1×10^{-19}
d) 1.76×10^{-19}

134. The energy band gap of Si is

a) 0.70 eV
b) 1.1 eV
c) between 0.70 eV to 1.1 eV
d) 5 eV

135. Eg for silicon is 1.12 eV and that for germanium is 0.72 eV . Therefore, it can be concluded that

a) more number of electron-hole pairs will be generated in silicon than in germanium at room temperature
b) less number of electron-hole pairs will be generated in silicon than in germanium at room temperature
c) equal number of electron-hole pairs will be generated in both at lower temperatures
d) equal number of electron-hole pairs will be generated in both at higher temperatures

N.B.Navale

Date : 28.03.2025
Time : 02:01:30
Marks : 135

TEST ID: 44
PHYSICS

SEMICONDUCTORS

: ANSWER KEY :

1)	a	2)	c	3)	c	4)	c
5)	b	6)	c	7)	b	8)	b
9)	c	10)	c	11)	b	12)	a
13)	a	14)	a	15)	a	16)	d
17)	b	18)	c	19)	b	20)	c
21)	d	22)	d	23)	d	24)	b
25)	b	26)	c	27)	c	28)	d
29)	c	30)	c	31)	c	32)	b
33)	a	34)	b	35)	c	36)	b
37)	b	38)	b	39)	c	40)	c
41)	a	42)	c	43)	a	44)	b
45)	b	46)	b	47)	d	48)	b
49)	b	50)	b	51)	a	52)	b
53)	c	54)	d	55)	c	56)	a
57)	c	58)	c	59)	c	60)	a
61)	d	62)	a	63)	a	64)	c
65)	a	66)	d	67)	c	68)	d
69)	c	70)	c	71)	a	72)	d
73)	b	74)	b	75)	b	76)	c
77)	b	78)	a	79)	c	80)	d
81)	a	82)	a	83)	b	84)	d
85)	b	86)	a	87)	d	88)	d
89)	b	90)	c	91)	c	92)	d
93)	c	94)	d	95)	d	96)	c
97)	b	98)	a	99)	b	100)	c
101)	a	102)	c	103)	c	104)	d
105)	a	106)	c	107)	d	108)	b
109)	b	110)	b	111)	b	112)	a
113)	b	114)	d	115)	b	116)	a
117)	a	118)	b	119)	b	120)	b
121)	c	122)	d	123)	b	124)	d
125)	a	126)	d	127)	d	128)	a
129)	b	130)	b	131)	b	132)	c
133)	c	134)	b	135)	b		

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PHYSICS

SEMICONDUCTORS

: HINTS AND SOLUTIONS :

Single Correct Answer Type

1 **(a)**
For a semiconductor, $0 < E_g \leq 3\text{eV}$ Generally, forbidden energy gap in semiconductor is near about 1eV.

2 **(c)**
The forward voltage overcomes the barrier voltage. Due to which, the forward current is high but depends upon the forward voltage applied.
The reverse voltage supports the barrier voltage due to which the reverse current is low.

3 **(c)**
Energy gap, $E_g = \frac{hc}{\lambda}$ and $\lambda = \frac{hc}{E_g} = \frac{12400}{0.72} \approx 17222\text{Å}$

4 **(c)**
In insulators, conduction band is empty and valence band is filled with electrons.

5 **(b)**
In case of $p - n$ junction diode, when it is reverse biased, the reverse voltage supports the barrier potential and hence the width of the depletion layer increases.
In forward biasing, the width decreases as the forward voltage opposes the potential barrier.
The width of the depletion region increases, if the diode is further doped heavily as the movement of charge carrier decreases.

Also, when the $p - n$ junction is light they doped, the width of depletion region increases, due to increase in the potential barrier.

6 **(c)**
In the forward biased mode, the $p - n$ junction diode acts as closed switch.

7 **(b)**
The pure silicon has negative temperature coefficient of resistivity.
At absolute zero temperature, its resistance becomes infinite and acts like an insullator.

8 **(b)**
In reverse bias p-n junction diode depletion layer width increases

9 **(c)**
Forbidden energy gap for Ge is very small as 0.72eV. Hence, at room temperature, some covalent bonding is broken in Ge crystal. Hence, its conductivity lies in the conductivity range of semiconductor.

10 **(c)**
Reverse bias applied to a p - n junction diode raises the potential barrier because p-type material connected to the negative terminal and pushes the holes away from the junction.
Similarly, n-type material connected to positive terminal and pushes the electrons away from junction. Therefore, the depletion region widens.

11 **(b)**
The majority charge carriers in p-type and n-type semiconductor are respectively holes and electrons

12 **(a)**
Semiconductor devices are operated at low power. At high voltage, these devices are burnt.

13 **(a)**
In semiconductor, as the temperature increases, more thermal energy becomes available to electrons and some of these electrons may their bonds (becoming free electrons contributing to conduction).
Thus, the thermal energy effectively ionises only a few atoms in the crystalline lattice and creates a vacancy in the bond called holes. These holes behave as positive charge carriers.

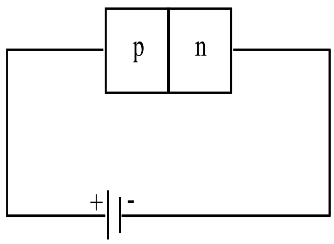
14 **(a)**
The diffusion current in a $p - n$ junction diode

flows p-side to n-side.

15 **(a)**
In intrinsic semiconductor at ordinary temperature, number of free electrons per unit volume (n_θ) = number of holes per unit volume (n_h).

16 **(d)**
In a p-type semiconductor the germanium is dopped with trivalent atoms like aluminium, boron and gallium.

17 **(b)**
In the forward bias arrangement of a p - n junction diode, the p-end is connected to the positive terminal of the battery.



18 **(c)**
Since the potential at the anode (1 V) is less than the potential at the cathode (2V), the diode is reverse biased and hence will not conduct and the current will be zero.

19 **(b)**
In good conductors, which are metals there is no gap between valence band and conduction band. Hence, no holes exist.

20 **(c)**
Theory question

22 **(d)**
The conductivity of a semiconductor increases with increase in temperature, because the number density of current carriers increases, relaxation time decreases but effect of decrease in relaxation is much less than increase in number density.

23 **(d)**
The diode is forward biased.

Potential difference$= 5 - 3 = 2$ V

$$\mathrm{I} = \frac{\mathrm{V}}{\mathrm{R}} = \frac{2}{200} = 10^{-2}\ \mathrm{A}$$

25 **(b)**
In forward biasing, the diffusion current increases and drift current remains constant, so net current is due to diffusion. In reverse biasing diffusion is not possible, so net current (very small) is due to the drift.

26 **(c)**
Theoretical question

27 **(c)**
At room temperature, a p-type semiconductor has large number of holes and few electrons.

28 **(d)**
Breakdown of semiconductor device occurs due to the flow of large current.

29 **(c)**
Depletion layer in $p - n$ junction region is caused by diffusion of charge carriers.

30 **(c)**
In n-type extrinsic semiconductor, conduction electron concentration (n_e) is greater than concentration of hole $\left(n_p\right)$. i.e. $n_e > n_p$.

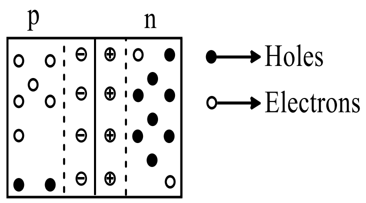
31 **(c)**
In intrinsic semiconductors, the number of free electron, n_e is equal to the number of holes n_h, i.e. $n_e = n_h = n_i$, where n_j is called intrinsic carrier concentration, $I = I_p + I_e$.

32 **(b)**
Holes behave as positive charge carriers, electrons have negative charge. Thus, gallium Arsenide is an alloy semiconductor where Ga contributes holes and As contributes electrons.

33 **(a)**
For metal, $E_\mathrm{g} = 0$, hence valence band and conduction band overlap each other.

34 **(b)**
In reverse bias $p - n$ junction diode, depletion layer width increases.

35 **(c)**
At junction, a potential barrier/depletion layer is formed with n-side at higher potential and p-side at lower potential. Therefore, there is an electric field at the junction directed from the n-side to p-side.



36 **(b)**
Resistance of thermistor changes with change in temperature of surrounding.

37 **(b)**
The concept of hole describes the lack of an electron at a position where one could exist in an atom or atomic lattice. If an electron is excited into a higher state, it leaves a hole in its old state. Thus, hole can be defined as a vacancy created when an electron leaves a covalent bond.

39 **(c)**
The n-type semiconductor can be produced by doping an impurity atom of valence 5 i.e. pentavalent atoms, i.e. phosphorus.

40 **(c)**
In forward biasing condition, the inner electric field is

given by $E = -\frac{\Delta V}{\Delta r}$

Or

$$|E| = \frac{\Delta V}{\Delta r} = \frac{5 \times 10^{-1}}{10^{-6}}$$
$$= 5 \times 10^{5} \mathrm{Vm}^{-1}$$

41 **(a)**
Drift current in a $p - n$ junction diode flows in the direction of electric field applied, i.e. from n-side to p-side.

43 **(a)**
In forward biased diode connection, p-side is at higher potential and n-side is at lower potential.

44 **(b)**
$E_g(\mathrm{Si}) > E_g(\mathrm{Ge}) < E_g\,(\mathrm{C})$

45 **(b)**
In an extrinsic semiconductor, $n_e n_h = (n_i)^2$

$$n_e \times 4.5 \times 10^{22} = (15 \times 10^{16})^2$$

$$n_e = \frac{2.25 \times 10^{32}}{4.5 \times 10^{22}} = 5 \times 10^{9}$$

46 **(b)**
Pentavalent impurity atom is to be added to Ge crystal, so as to make a n-type semiconductor.

47 **(d)**
When temperature of intrinsic semiconductor increases, then due to breaking of some more covalent bonding, some extra electron-hole pair are generated, hence conductivity of intrinsic semiconductor increases. When temperature of p-type semiconductor increases, then charge carriers and its mobility increases, hence its conductivity is increased.

49 **(b)**
Pure Cu is already an excellent conductor, since it has a partially filled conduction band. Further more, Cu forms a metallic crystal as opposed to the covalent crystals of silicon or germanium, so the process of using an impurity of donate or accept an electron does not work for copper. Infact adding impurities to copper decreases the conductivity because an impurity tends to scatter electrons, impeding the flow of current.

50 **(b)**
When a small amount of antimony is added to germanium crystal, the crystal becomes n-type semiconductor because antimony is a pentavalent impurity. In n-type semiconductor, large number of free electrons are produced, hence electrons become majority carriers.

51 **(a)**
In semiconductors, at a room temperature, the valence band is partially empty and the conduction band is partially filled.

52 **(b)**
Potential barrier developed in $p - n$ junction diode opposes the flow of majority carriers only.

53 **(c)**
An n-type semiconductor by itself has mainly negative charge carriers (electrons) which are able to move freely, but it is still neutral because the fixed donar atoms, having donated electrons, are positive. Hence, n-type material is neutral.

54 **(d)**

$$\mathrm{n_e} = 10^{16} \text{ per m}^3, \mathrm{n_e} = \frac{10^{21}}{\mathrm{m}^3}, \mathrm{n_n} = ?$$

$\therefore n_e n_h = n_i^2$

$\therefore n_h = \frac{n_i^2}{n_e} = \frac{(10^{16})^2}{10^{21}}$

$= \frac{10^{32}}{10^{21}} = 10^{11}/m^3$

55 **(c)**
Integrated circuit is an electronic device in which thousands of diodes and transistors are fabricated on single chip.

56 **(a)**
When conductivity of semiconductor is only due to breaking of covalent bond, then semiconductor is intrinsic or pure semiconductor.

57 **(c)**
The thickness of depletion region of $p - n$ junction is of the order 10^{-6} m.

58 **(c)**
Si and Ge have four valence electrons. In its crystalline structure, every Si or Ge atom tends to share one of its four valence electrons with each of its four nearest neighbour atoms and also to take share of one electron from each such neighbour.

These shared electron pairs are referred to as forming a covalent bond or simply a valence band.

61 **(d)**
Curve S shows forward bias characteristics of a diode.

63 **(a)**
Due to the reverse biasing, the width of depletion region increases and current flowing through the diode is almost zero. In this case, electric field is almost zero at the middle of the depletion region.

64 **(c)**
The diffusion of charge carriers across a junction takes place from the region of higher concentration. In this case, hole concentration in p-region is more as compared to n-region.

65 **(a)**
In forward bias of $p - n$ junction, diffusion current is due to majority carriers and drift current is due to minority carriers, hence diffusion current is greater than drift current in $p - n$ junction.

67 **(c)**
The diode is forward biased. The potential difference between P and Q is $(3 — 5) = 8$ V.

$I = \frac{V}{R} = \frac{8}{2 \times 10^3} = 4 \times 10^{-3}$ A

68 **(d)**
An n-type and p-type silicon semiconductor can be obtained by doping pure silicon with arsenic and boron respectively

69 **(c)**
In the case of forward bias, the potential barrier opposes the applied voltage. Hence, the potential across the junction gets reduced.

70 **(c)**
On increasing the temperature, the current in the circuit will increase because with rise in temperature, resistance of semiconductor decreases, hence overall resistance of the circuit decreases, which in turn increases the current in the circuit.

71 **(a)**
In insulators, the forbidden energy gap is quite large. For example, the forbidden energy gap for diamond is 6eV, which means that minimum of 6eV energy is required to make the electron jump from the completely filled valence band to conduction band.
Hence, for insulator, $3\text{eV} < E_g < 6\text{eV}$.

72 **(d)**
Theory question

74 **(b)**
p-type semiconductor is obtained by adding a small amount of trivalent impurity to a pure sample of semiconductor (Ge).
In p-type semiconductor, majority charge carriers are holes and minority charge carriers are electrons
However, n-type semiconductor is obtained by adding a small amount of pertavalent impurity to a pure sample of semiconductor (Ge).
In n-type semiconductor, majority charge carriers are electrons and minority charge carriers are holes.
The resistance of intrinsic semiconductors

decreases with increase of temperature.

76 **(c)**
Resistivity of conductors increases with temperature and that of semiconductor decreases with temperature.

When temperature is decreased, the resistivity of copper will decrease while that of silicon will increase.

77 **(b)**
The difference in the variation of resistance with temperature in metal and semiconductor is caused due to difference in the variation of the number of charge carriers with temperature.

78 **(a)**
At room temperature, a p-type semiconductor has large number of holes and few electrons, as holes are majority charge carriers.

79 **(c)**
Doping elements are called impurities, therefore the process of adding impurities to the pure semiconductor is known as doping.

82 **(a)**
In a semiconductor diode, the barrier potential offers opposition to the flow of electrons from n-region to p-region and holes from p-region to n-region, i.e. barrier potential offers opposition to only majority carriers in both regions.

84 **(d)**
In an extrinsic semiconductor, if doping is done by using a pentavalent impurity, then number of electrons are more than number of holes and if a trivalent impurity is used, then number of holes are more than number of electrons.

85 **(b)**
If p-n junction diode is reversed biased, width of depletion layer increases.

86 **(a)**
As we know, current density, $J = nqv$

$\Rightarrow J_e = n_e q v_\theta$ and $J_h = n_h q v_h$

or $\frac{J_\theta}{J_h} = \frac{n_e}{n_h} \times \frac{v_e}{v_h} \Rightarrow \frac{\frac{3}{4}}{\frac{1}{4}} = \frac{n_e}{n_h} \times \frac{5}{2} \Rightarrow \frac{n_e}{n_h} = \frac{6}{5}$

87 **(d)**
Theory question

89 **(b)**
In a p-type semiconductor, holes are majority carriers and trivalent atoms are dopants.

90 **(c)**
The n-type semiconductor can be obtained by doping a pentavalent impurity e.g. Phosphorous. In this semiconductor, holes are minority charge carriers and electrons are majority charge carriers.

92 **(d)**
The four number of electrons are found in the valence shell of a semiconductor.

93 **(c)**
The conductivity of a semiconductor is given by
$\sigma = n_e e \mu_e + n_h e \mu_h$
where, $n_e \& n_h$ = number of electrons & holes per unit volume
and $\mu_e \& \mu_h$ = mobility of electrons & holes.
When impurity atoms are added in a semiconductor, then the concentration of holes and electrons increases. So, the conductivity increases and hence the resistivity $\left(\rho = \frac{1}{\sigma}\right)$ of semiconductor decreases.

95 **(d)**
Electrical conductivity of insulators is extremely small because very few electrons are present in conduction band.

96 **(c)**
In circuit X, both the diodes are forward biased and hence both will conduct.
The two resistances of 4 Ω each are in parallel. Their equivalent resistance is 2Ω. Hence the current

$\mathrm{I} = \frac{\mathrm{v}}{\mathrm{R}} = \frac{8}{2} = 4\ \mathrm{A}$

In the circuit Y, the diode $\mathrm{D_1}$ is forward biased but diode $\mathrm{D_2}$ is reverse biased. Hence only diode $\mathrm{D_1}$ will contact. The resistance is 4 A.

Hence $\mathrm{I} = \frac{8}{4} = 2\ \mathrm{A}$

97 **(b)**
Germanium is a semiconductor and possesses negative temperature coefficient. Therefore, when temperature of germanium is decreased, its resistance increases.

99 **(b)**
The diode is forward bias and hence it will conduct. Its resistance is taken as zero.

P. D. between P and Q$= 4-(-6) = 10$ V

$$\mathrm{I} = \frac{\mathrm{V}}{\mathrm{R}} = \frac{10}{10^3} = 10^{-2}\ \mathrm{A}$$

100 **(c)**
At absolute zero temperature, intrinsic semiconductor behaves as insulator

103 **(c)**
Devices in which a controlled flow of electrons can be obtained are the basic building blocks of all the electronic circuits.

104 **(d)**
When forward bias is applied to a p-n junction then V_B decreases and W decreases.

105 **(a)**
As $n_e > h_h$, so semiconductor is n-type.

$$\text{Also, conductivity } (\sigma) = \frac{1}{\text{Resistivity } (\rho)} = e(n_e\mu_e + n_h\mu_h)$$

$$\Rightarrow \frac{1}{\rho} = 16 \times 10^{-19}[8 \times 10^{18} \times 2.3 + 5 \times 10^{18} \times 0.01]$$

$$\Rightarrow \rho = 0.34\Omega - \mathrm{m}$$

106 **(c)**
The majority charge carriers in p-type semiconductor are holes, while electrons are minority charge carriers.

107 **(d)**
The trivalent impurities provide holes to create positive charge carriers in p-type semiconductor. Hence, majority carriers in p-type semiconductor are holes.

108 **(b)**
In circuit (a) the two diodes are in series and one of the diodes is reverse biased. Hence no current will flow in the circuit and ammeter will not show any deflection.

109 **(b)**
(i) **Metals** They possess very low resistivity (or high conductivity).

$\rho \sim 10^{-2} - 10^{-8}\Omega - m, \sigma \sim 10^2 - 10^8\mathrm{Sm}^{-1}$

(ii) **Semiconductors** They have resistivity or conductivity intermediate to metals and insulators.

$\rho - 10^{-5} - 10^{6}\Omega - m, \sigma \sim 10^5 - 10^{-6}\mathrm{Sm}^{-1}$

(iii) **Insulators** They have high resistivity (or low conductivity).

$\rho \sim 10^{11} - 10^{19}\Omega - m$

$\sigma \sim 10^{-11} - 10^{-19}\ \mathrm{S\ m}^{-1}$

As, $10^8 > 10^5 > 10^{-19} \Rightarrow \sigma_m > \sigma_s > \sigma_i$

111 **(b)**
In n-type semiconductor,, pentavalent impurity are dopants and electrons are majority carriers.

112 **(a)**
At the atomic separation of 2Å to 3Å, the energy of outermost electrons changes by larger amounts due to atomic interactions.

113 **(b)**
In a reverse biased p-n junction, when the applied voltage is equal to the breakdown voltage, then voltage remains constant while current increases sharply.

114 **(d)**
Resistance of conductor (Cu) decreases with decrease in temperature while that of semiconductor (Ge) increases with decrease in temperature because coefficient of thermal resistance is positive for copper and negative for germanium.

115 **(b)**
The electrical conductivity of p-type semiconductor is determined by the number of holes.

116 **(a)**
Theory question

117 **(a)**
$$\mathrm{I} = \frac{3-1}{100} = \frac{2}{100} = 2 \times 10^{-2} = 20 \times 10^{-3}\ \mathrm{A}$$

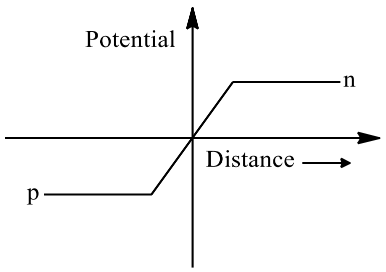
118 **(b)**

Diode D_1 is forward biased, while diode D_2 is reverse biased. Hence current will flow only through D_1. Total resistance

$3 + 2 = 5\Omega$

$\therefore I = \frac{V}{R} = \frac{10}{5} = 2\ A$

120 **(b)**
Graph between potential and distance in a $p-n$ junction diode is given by



$\therefore$ Potential at p is less than that at n.

121 **(c)**
To form an n-type semiconductor doping is done by using a pentavalent impurity, like phosphorous, arsenic, etc. and to form a p-type semiconductor doping is done by using a trivalent impurity like indium, boron, etc.

122 **(d)**
A solid with completely filled valence band is an insulator, if the energy gap between the valence band and the empty conduction band is larger than 3eV.

123 **(b)**
In reverse biasing of $p-n$ junction diode, the applied reverse voltage establishes an electric field which acts in the same direction as the electric field in the potential barrier. Therefore, the height of potential barrier is increased.

124 **(d)**
Extrinsic semiconductors are also electrically neutral.

125 **(a)**
Mobility of electrons are higher than that of holes because electrons need less energy to move.

126 **(d)**
The forward voltage overcomes the barrier voltage. Due to which, the forward current is high but depends upon the forward voltage applied. The reverse voltage supports the barrier voltage due to which the reverse current is low.

127 **(d)**
In a good conductor, the conduction band and valence band overlap each other. Hence, energy gap, $E_g = 0$.

128 **(a)**
The probability of electrons to be found in the conduction band of an intrinsic semiconductor at a finite temperature decreases exponentially with increasing band gap.

129 **(b)**
At a specific reverse voltage in $p-n$ junction, a huge current flows in reverse direction known as Avalanche current.

130 **(b)**
$n_i = 1.6 \times 10^{16}\ m^{-3}, n_h = 4 \times 10^{22}\ m^{-3}$

$n_e n_h = n_i^2$

$\therefore n_e = \frac{n_i^2}{n_h} = \frac{(1.6 \times 10^{16})^2}{4 \times 10^{22}} = \frac{1.6 \times 1.6 \times 10^{32}}{4 \times 10^{22}}$

$= 6.4 \times 10^9\ m^{-3}$

132 **(c)**
If n_i is the number density of electrons and holes in intrinsic (pure) semiconductor and n_e and n_h are electron and hole number carrier in extrinsic (doped) semiconductor then we have

$n_e n_h = n_i^2$

$n_e = \frac{n_i^2}{n_h} = \frac{1.5 \times 10^{16} \times 1.5 \times 10^{16}}{4.5 \times 10^{22}} = 5 \times 10^9$

133 **(c)**
Semiconductors are similar to insulators but the conduction and valence bands are spaced closely, so that at room temperature, a number of electrons are found in conduction band. For germanium, forbidden energy gap $= 0.70\text{eV} = 0.70 \times 16 \times 10^{-19} = 1.12 \times 10^{-19}\ J = 1.1 \times 10^{-19}\ J$

134 **(b)**
The energy band gap of Si is 1.1eV.

135 **(b)**

At room temperature, forbidden energy gap for Si (1.12eV) is higher than the forbidden energy gap of Ge (0.72eV). Hence, at room temperature, less number of electron-hole pairs will be generated in silicon than in germanium.